UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/578,004	05/03/2006	Atsushi Ikeda	071971-0547	5214

53080 7590 03/14/2008

MCDERMOTT WILL & EMERY LLP
600 13TH STREET, NW
WASHINGTON, DC 20005-3096

EXAMINER	
YEUNG LOPEZ, FEIFEI	
ART UNIT	PAPER NUMBER
2826	
MAIL DATE	DELIVERY MODE
03/14/2008	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No.	Applicant(s)	
	10/578,004	IKEDA ET AL.	
	Examiner	Art Unit	
	FEI FEI YEUNG LOPEZ	2826	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *10 December 2007*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-24* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-24* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

2. The factual inquiries set forth in *Graham* **v.** *John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

3. Claims 1-7,9, and 12 are rejected under 35 U.S.C. 103(a) as being unpatentable over Bernstein et al (US Patent 6,452,251 B1), in view of Zhang et al (US Patent 6,420,740 B1), further in view of Wang et al (US Patent 6,462,417 B1).

4. Regarding claim 1, Bernstein teach that a semiconductor device comprising: an insulation film (film 29 in fig. 1F) formed on a substrate (insulator 22); a buried interconnect (copper layer 53) formed in the insulation film; and a barrier metal film (layers 41, 49, 51) formed between the insulation film and the buried interconnect, wherein the barrier metal film is formed of a lamination film of a metal compound film (layer 41 in fig. 1F) and a metal film (layer 51 in fig. 1F, column 4, lines 17-21). However, Bernstein do not teach that the metal film having a property of not losing its

conductivity when being oxidized. In the same field of endeavor, Zhang teach a metal which does not lose its conductivity when being oxidized (column 2, lines 4-5) for the benefit of having good adhesion with the substrate (column 2, lines 59-61). Thus, it would have been obvious to one of ordinary skill in the art at the time of the invention to use a metal which does not lose its conductivity when being oxidized for the benefit of having good adhesion with the substrate. Also, Bernstein do not teach a fusion layer present in between the metal compound film and the metal film and that the fusion layer obtained through fusion of the metal compound film and the metal film with each other. In the same field of endeavor, Wang teach *a fusion layer (CuTi layer 226 in fig. 3) and wherein the fusion layer is present in between a metal compound film (layer 227) and a metal film (layer 228), and the* fusion layer *is* obtained through fusion of the metal compound film (TiN barrier material interface 227 in fig. 3) and the metal film (copper seed layer 228 in fig. 3, column 5, lines 26-52) with each other is present in the vicinity of an interface between the metal compound film and the metal film for the benefit of forming a strong coherent bond (column 5, lines 47-52). Thus, it would have been obvious to one of ordinary skill in the art at the time of the invention to form a fusion layer obtained through fusion of the metal compound film and the metal film with each other is present in the vicinity of an interface between the metal compound film and the metal film for the benefit of forming a strong coherent bond.

5. Regarding claim 2, Bernstein do not teach that the semiconductor device of claim 1, wherein a metal forming the metal compound film and a metal forming the metal film are different elements from each other.

6. Wang teach that a metal forming the metal compound film and a metal forming the metal film are different elements from each other (column 5, lines 5-52).

7. Regarding claim 3, Bernstein teach that the semiconductor device of claim 1, wherein a metal forming the metal compound film and a metal forming the metal film are the same element (column 4, lines 17-21).

8. Regarding claim 4, Bernstein do not teach the fusion layer includes at least several atomic layers.

9. Wang teach the fusion layer includes at least several atomic layers (the alloy-barrier material has 10 to 100 angstroms of thickness, column 5, lines 67-68).

10. Regarding claim 5, Bernstein teach the metal compound film is formed so as to be jointed with the insulation film (film 29 in fig. 1F).

11. Bernstein do not teach the metal film is formed on the metal compound film.

12. Wang teach the metal film is formed on the metal compound film.

13. Regarding claim 6, Bernstein teach that the semiconductor device of claim 1, wherein a metal forming the metal compound film is a refractory metal (column 4, lines 17-21).

14. Regarding claim 7, Bernstein teach that the semiconductor device of claim 1, wherein the metal compound film has conductivity (column 3, lines 37-38 and column 4, lines 17-21).

15. Regarding claim 9, Bernstein do not teach that the semiconductor device of claim 1, wherein the metal compound film is formed of a metal nitride film.

16. Wang teach that the metal compound film is formed of a metal nitride film (TiN barrier material, layer 227 in fig. 3, lines 26-39).

17. Regarding claim 12, Bernstein teach that the semiconductor device of claim 1, wherein the buried interconnect is formed of copper (layer 53, fig. 1F, column 4, lines 30-31).

18. Claims 13,16,18-19, and 24 are rejected under 35 U.S.C. 103(a) as being unpatentable over Bernstein et al (US Patent 6,452,251 B1), in view of Kim et al (US Patent (6,936,535 B2), and further in view of Zhang et al (US Patent 6,420,740 B1).

19. Regarding claim 13, Bernstein teach that a method for fabricating a semiconductor device, comprising the steps of: forming a recess portion in an insulation film (insulating layer 29 in fig. 1F) provided on a substrate (insulator 22); forming a barrier metal film (layers 41,49, and 51) so that the barrier metal film covers *a surface* of the recess portion; and forming a buried interconnect (copper layer 53) on the barrier metal film so that the recess portion is filled, wherein the step of forming the barrier metal film includes the step of forming a metal compound film (layer 41 in fig. 1F, column 4, lines 17-21) on the surface of the recess portion and then forming on the metal compound film a metal film (layer 51 in fig. 1F). However, Bernstein do not teach a fusion layer resulting from forming a metal film on a metal compound film.

20. In the same field of endeavor, Kim teach a fusion layer (Al diffusing into layers 32-1, see column 7, lines 53-56) obtained between a metal compound film (layer 32-1 in fig. 7) and a metal film (Al layer 34) for the benefit of effectively blocking Cu diffusion

(column 7, lines 57-58). Thus, it would have been obvious to one of ordinary skill in the art at the time of the invention to make a fusion layer obtained between a metal compound film (layer 32-1 in fig. 7) and a metal film (Al layer 34) for the benefit of effectively blocking Cu diffusion. However, Bernstein and Kim do not teach forming the metal film by physical vapor deposition and the metal film not losing its conductivity when being oxidized. In the same field of endeavor, Zhang teach a using PVD to make a barrier layer, and a metal which does not lose its conductivity when being oxidized (column 2, lines 4-5) for the benefit of having good adhesion with the substrate (column 2, lines 59-61). Thus, it would have been obvious to one of ordinary skill in the art at the time of the invention to use PVD to make the metal film and a metal which does not lose its conductivity when being oxidized for the benefit of having good adhesion with the substrate.

21. Regarding claim 16, Bernstein teach that the method of claim 13, wherein a metal forming the metal compound film and a metal forming the metal film are the same element (column 4, lines 17-21).

22. Regarding claim 18, Bernstein teach that the method of claim 13, wherein a metal forming the metal compound film is a refractory metal (column 4, lines 17-21).

23. Regarding claim 19, Bernstein teach that the method of claim 13, wherein the metal compound film has conductivity (layer 41 in fig. 1F, column 3, lines 37-39).

24. Regarding claim 24, Bernstein teach that the method of claim 13, wherein the buried interconnect is formed of copper (copper layer 53 in fig. 1F).

25. Claim 14-15, 17, and 21 are rejected under 35 U.S.C. 103(a) as being unpatentable over Bernstein et al (US Patent 6,452,251 B1), in view of Kim et al (US Patent (6,936,535 B2), and further in view of Zhang et al (US Patent 6,420,740 B1) as applied to claim 13 above, and further in view of Wang et al (US Patent 6,462,417 B1).

26. Regarding claim 14, the previous combination remains as applied in claim 13. Also, Bernstein teach the step of forming the buried interconnect (copper layer 53) that fills the recess portion (fig. 1F). However, the previous combination does not teach the step of forming a seed layer on the barrier metal film. In the same field of endeavor, Wang teach forming a seed layer (layer 228 in fig. 3) on the barrier metal film for the benefit of forming a strong coherent bond (column 5, lines 47-52). Thus, it would have been obvious to one of ordinary skill in the art at the time of the invention to include a seed layer on the barrier metal film for the benefit of forming a strong coherent bond.

27. Regarding claim 15, the previous combination remains as applied in claim 13. However, the previous combination does not teach a metal forming the metal compound film and a metal forming the metal film are different elements from each other. In the same field of endeavor, Wang teach that a metal forming the metal compound film and a metal forming the metal film are different elements from each other (column 5, lines 5-52) for the benefit of forming a strong coherent bond (column 5, lines 47-52). Thus, it would have been obvious to one of ordinary skill in the art at the time of the invention to include a metal forming the metal compound film and a metal forming the metal film

different elements from each other for the benefit of forming a strong coherent bond (column 5, lines 47-52).

28. Regarding claim 17, the previous combination remains as applied in claim 13. However, the previous combination does not teach a fusion layer. In the same field of endeavor, Wang teach that a fusion layer (CuTi layer 226 in fig. 3) obtained through fusion of the metal compound film (TiN barrier material interface 227 in fig. 3) and the metal film (copper seed layer 228 in fig. 3, column 5, lines 26-52) with each other is present in the vicinity of an interface between the metal compound film and the metal film, and wherein the fusion layer includes at least several atomic layers (column 5, lines 56-59), for the benefit of forming a strong coherent bond (column 5, lines 47-52). Thus, it would have been obvious to one of ordinary skill in the art at the time of the invention to form a fusion layer obtained through fusion of the metal compound film and the metal film with each other is present in the vicinity of an interface between the metal compound film and the metal film, and wherein the fusion layer includes at least several atomic layers for the benefit of forming a strong coherent bond.

29. Regarding claim 21, the previous combination remains as applied in claim 13. However, the previous combination does not teach a metal nitride film. In the same field of endeavor, Wang teach a metal compound film is formed of a metal nitride film (TiN barrier material, layer 227 in fig. 3, lines 26-39).

30. Claim 8 is rejected under 35 U.S.C. 103(a) as being unpatentable over Bernstein et al (US Patent 6,452,251 B1), in view of Zhang et al (US Patent 6,420,740 B1), further

in view of Wang et al (US Patent 6,462,417 B1) as applied to claim 1 above, and still further in view of Asahina et al (US Patent 6,144,097).

31. Regarding claim 8, the previous combination remains as applied in claim 1. However, the previous combination does not teach the metal compound film formed of a metal oxide film. In the same field of endeavor, Asahina teach that a metal compound film is formed of a metal oxide film for the benefit of improving the barrier properties (column 1, lines 40-44). Thus, it would have been obvious to one of ordinary skill in the art at the time of the invention to include the metal compound film formed of a metal oxide film for the benefit of improving the barrier properties.

32. Claim 20 is rejected under 35 U.S.C. 103(a) as being unpatentable over Bernstein et al (US Patent 6,452,251 B1), in view of Kim et al (US Patent (6,936,535 B2), and further in view of Zhang et al (US Patent 6,420,740 B1) as applied to claim 13 above, and further in view of Asahina et al (US Patent 6,144,097).

33. Regarding claim 20, the previous combination remains as applied in claim 13. However, the previous combination does not teach the metal compound film formed of a metal oxide film. In the same field of endeavor, Asahina teach that a metal compound film is formed of a metal oxide film for the benefit of improving the barrier properties (column 1, lines 40-44). Thus, it would have been obvious to one of ordinary skill in the art at the time of the invention to include the metal compound film formed of a metal oxide film for the benefit of improving the barrier properties.

34. Claim 10 is rejected under 35 U.S.C. 103(a) as being unpatentable over Bernstein et al (US Patent 6,452,251 B1), in view of Zhang et al (US Patent 6,420,740

B1), further in view of Wang et al (US Patent 6,462,417 B1) as applied to claim 1 above, and further in view of Wang et al (US Patent 6,445,070 B1).

35. Regarding claim 10, the previous combination remains as applied in claim 1. However, the previous combination does not teach the metal compound film formed of a metal carbide film. In the same field of endeavor, Wang teach a metal compound film formed of a metal carbide film for the benefit of forming a strong coherent bond (column 5, lines 28-52). Thus, it would have been obvious to one of ordinary skill in the art at the time of the invention to include a metal compound film formed of a metal carbide film for the benefit of forming a strong coherent bond.

36. Claim 22 is rejected under 35 U.S.C. 103(a) as being unpatentable over Bernstein et al (US Patent 6,452,251 B1), in view of Kim et al (US Patent (6,936,535 B2), and further in view of Zhang et al (US Patent 6,420,740 B1) as applied to claim 13 above, and further in view of Wang et al (US Patent 6,445,070 B1).

37. Regarding claim 22, the previous combination remains as applied in claim 13. However, the previous combination does not teach the metal compound film formed of a metal carbide film. In the same field of endeavor, Wang teach a metal compound film formed of a metal carbide film for the benefit of forming a strong coherent bond (column 5, lines 28-52). Thus, it would have been obvious to one of ordinary skill in the art at the time of the invention to include a metal compound film formed of a metal carbide film for the benefit of forming a strong coherent bond.

38. Claim 11 is rejected under 35 U.S.C. 103(a) as being unpatentable over Bernstein et al (US Patent 6,452,251 B1), in view of Zhang et al (US Patent 6,420,740

B1), further in view of Wang et al (US Patent 6,462,417 B1) as applied to claim 1 above, and further in view of Terry et al (US Patent 4,675,713).

39. Regarding claim 11, the previous combination remains as applied in claim 1. However, the previous combination does not teach the metal compound film formed of a metal silicide film. In the same field of endeavor, Terry teach a metal compound film formed of silicide for the benefit of improving reliability (abstract). Thus, it would have been obvious to one of ordinary skill in the art at the time of the invention to include a metal compound film formed of silicide for the benefit of improving reliability.

40. Claim 23 is rejected under 35 U.S.C. 103(a) as being unpatentable over Bernstein et al (US Patent 6,452,251 B1), in view of Kim et al (US Patent (6,936,535 B2), and further in view of Zhang et al (US Patent 6,420,740 B1) as applied to claim 13 above, and further in view of Terry et al (US Patent 4,675,713).

41. Regarding claim 23, the previous combination remains as applied in claim 13. However, the previous combination does not teach the metal compound film formed of a metal silicide film. In the same field of endeavor, Terry teach a metal compound film formed of silicide for the benefit of improving reliability (abstract). Thus, it would have been obvious to one of ordinary skill in the art at the time of the invention to include a metal compound film formed of silicide for the benefit of improving reliability.

Response to Arguments

42. Applicant's arguments with respect to claims 1-24 have been considered but are moot in view of the new ground(s) of rejection.

Conclusion

43. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

1. Any inquiry concerning this communication or earlier communications from the examiner should be directed to FEI FEI YEUNG LOPEZ whose telephone number is (571)270-1882. The examiner can normally be reached on 7:30am-5:00pm Monday to Friday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Sue Purvis can be reached on 571-272-1236. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Leonardo Andújar/
Primary Examiner, Art Unit 2826

FYL /Feifei Yeung-Lopez/
Examiner, Art Unit 2826